CAUSALITY BETWEEN OIL CONSUMPTION AND ECONOMIC GROWTH IN OPEC COUNTRIES: A PANEL COINTEGRATION APPROACH

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ABSTRACT

This paper examined the relationship between oil consumption and economic growth in OPEC countries within a panel cointegration and panel based error correction model by using data from 1980 – 2011. In this paper we use unit root test and cointegration test for empirical test as gross domestic production (GDP) and oil consumption according to ADF test was integrated of one, we used Granger causality test. The results indicate the presence of a long run relationship among real GDP and oil consumption. The short run results also indicate the causality running from oil consumption to economic growth and vice-versa, supporting the feedback hypothesis which asserts that energy policies oriented toward improvements in oil consumption efficiency would not adversely affect real GDP. In other words we can say that energy efficiency have not a significant effect on economic growth in long – run. For this country there are any casualty between this variables in long-run.

Keywords: Oil, Economic growth, Cointegration approach, OPEC.

1. INTRODUCTION

OPEC countries have appropriate and privileged condition for energy resource in a relation to many other countries. These enormous resources could account as an important economical developing factor if they used in optimized and appropriate way, otherwise energy sector probably act as an unbalanced and inconsistent in connection to other economic sectors then cause to inappropriate growth of some sectors and consequently cause economic imbalances.

Oil now constitutes a critical factor in sustaining the well-being the OPEC countries as well as the nation's economic growth. Production in industries countries demands a substantial amount of oil. The improving in oil consumption have a significant effect in efficiency of automobiles and machines and introducing various kinds of tariff reforms aiming to control oil consumption patterns through leveling projected oil demand and saving supply costs of oil can induce a high degree of efficiency in the existing facilities without adversely affecting a high level of oil consumption for economic growth (Gudarzi farahani and Sadr Seyed Mohammad, 2012).

In any way, accepting this fact that energy has a crucial role in economic development of countries makes an inevitable affair to preserve nonrenewable resources, accurately and economically exploit from these energy sources Therefore, it seems necessary to investigate relation between energy consumption and produced goods in every country. Is there any relationship between increase of energy consumption and economic growth? The answer is significant because lack of proportionality between production and energy consumption lonely may demonstrate energy dissipation and inefficiency of energy consumption as a production factor.

There are many papers about examining the relationships between energy consumption and economic growth. There are four categories studies about energy consumption and economic growth: One of this approach is based on a traditional VAR (Sims, 1972) and Granger's causality testing, which assumed that the data are stationary (Erol and Yu, 1987); (Abosedra and Baghestani, 1989). Second of this approach assuming that the variables are non-stationary and consequently, the cointegration technique is the appropriate tool for investigating these relationships (Asafu-Adjaye, 2000).

Another approach is, based on the Granger two stage procedure; in this approach the variable are tested pairs by cointegrating relationships and error correction models to test for Granger causality (Glasure and Lee, 1997).

In the third approach multivariate estimators are based Johansen, which facilitated estimations of systems of equation where restrictions on cointegrating relations can be tested and information on short-run adjustment are investigated (see, e.g. (Masih and Masih, 1998; Asafu-Adjaye, 2000). The fourth approach using the Panel-based error correction models, which providing more powerful tests compared to the time series approach (Asafu-Adjaye, 2000; Gudarzi farahani and Sadr Seyed Mohammad, 2012).

This paper try to investigate the relationship between oil consumption and economic growth for OPEC countries according to Odhiambo (2010) and Gudarzi farahani and Sadr Seyed Mohammad (2012) article.

I this paper Section 2, describe the literature review about energy consumption. Section 3, describe the econometric methodology. Section 4 describe about data and empirical test. And conclusion bring in final section.

2. LITERATURE REVIEW

Gudarzi farahani and Sadr Seyed Mohammad (2012) investigated Causality between oil consumption and economic growth In Iran: an ARDL testing approach. Their results show that in the short-run, the Granger causality runs from economic growth to energy consumption In Iran.

Abbasinejad et al. (2012) examine the relationship between energy consumption, energy prices and economic growth in OPEC countries. They use cointegration approach to consideration the relationship between energy consumption and economic. They results show that in the short-run, the Granger causality runs from income to energy consumption for Iran, Iraq, Qatar, United Arab Emirates and Saudi Arabia while for the rest of the OPEC countries the reverse is true. In the case

of Qatar and the Saudi Arabia and Nigeria, energy, economic growth and prices aren't mutually causal. Also they results show, that even for these countries which the energy consumption has an effect on economic growth, the effect is very minimal. They conclude that for all of the OPEC countries the theory of resource curse holds.

Ighodaro (2010) examined the relationship between energy consumption and economic growth for Nigeria using data covering the period 1970 to 2005. He found that there existed a long run relationship among the series. It was also found that all the variables used for the study were integrated of order one.

Hondroyiannis *et al.* (2002) investigated the relationship between energy consumption, gross domestic product and the consumer price index (CPI) for Greece. In this paper they used annual data over the period 1960 to 1996 and found evidence for long run bi – directional causality between energy consumption gross domestic products.

Soytas and Sari (2003) consideration the relationship between energy consumption and economic growth in selected countries. For example in Korea and Italy they found causality running from GDP to energy consumption and for Turkey, France, Germany and Japan they found casualty from energy consumption to GDP. In another paper, Ghosh (2002) found no co-integration between energy consumption and GDP for India but there is unidirectional causality from GDP to electricity consumption (see.(Ighodaro, 2010).

3. METHODOLOGY

3.1. The Unit Root Test of Panel data

In first section for possibility of panel cointegration to consideration relationship between variables, it is first necessary to determine the order of integration of variables. Levine and Lin (1993) proposes a panel-based ADF test that restricts parameters γ_i by keeping them identical across cross-sectional regions as follows (Gudarzi farahani and Sadr Seyed Mohammad, 2012):

$$\Delta y_{it} = \alpha_i + \gamma_i y_{it-1} + \sum_{j=1}^{k} \alpha_j \, \Delta y_{it-j} + e_{it} \qquad (1)$$

where t =1,. . ., T time periods and i =1,. . .N members of the panel. In this test the null hypothesis is variable has a unit root.

3.2. Panel Cointegration

The next step is to test for the existence of a long-run cointegration among GDP and the independent variables using panel cointegration tests suggested by (Pedroni, 1999); Pedroni (2004). Cointegration analysis is used to determine whether a long-run relationship exists among nonstationary variables. This paper considers the method by (Pedroni, 1999);Pedroni (2004) which uses a series of spurious regressions and evaluates the residuals to determine variables are cointegrated.

If the variables are cointegrated then the residuals should be I(0), and if the variables are not cointegrated then the residuals will be I(1). The panel cointegration tests Pedroni (1999) considers the following regression

$$y_{it} = \alpha_{it} + \delta_{it}\, t + X_i B_i + e_{it} \tag{2}$$

Where y_{it} and X_{it} are the observable variables with dimension of $(N * T) \times 1$ and $(N * T) \times m$, respectively.

3.3. Fully Modified Ordinary Least Squares (FMOLS) Estimation

In this section we adopt FMOLS procedure from Abdullah *et al.* (2007). "In order to obtain asymptotically efficient and consistent estimates in panel series, non-exogeneity and serial correlation problems are tackled by employing fully modified OLS (FMOLS) introduced by (Pedroni, 1999). We estimate the Equation (2) by the method or fully modified OLS (FMOLS) for heterogeneous cointegrated panels (Abdullah *et al.*, 2007).

4. RESULTS

4.1. Panel Nit Root Test and Panel Cointegration Test

We apply a model to examine the causal relationship between oil consumption and economic growth included in model as conditioning variable along with these variables. The data used in this study consist of annual time series of GDP and oil consumption for OPEC countries 1980 to 2011. The series for Iran cover the period 1980-2011; the data are obtained from BP Statistical Review2011, the Titi Tudorancea Bulletin and World Bank.

Table 1 presents the panel unit root tests. At a 5% significance level, all statistic of the level model confirm that this series have a panel unit root. Using these results, we proceed to test GDP, and oil consumption for cointegration in order to determine if there is a long-run relationship to control for in the econometric specification. Based on the results from the panel unit roots we conclude for all variables, the null of a unit root cannot be rejected in their levels. At first differences, however, the null is strongly rejected in all cases. We conclude that all series are integrated of order one $I(1)$ in the constant plus time trend of the panel unit root regression.

Table-1. Panel unit root tests

Variable	Levin, Lin and Chut		Im, Pesaran and Shin (IPS)	
	No time effects	Time fixed effects	No time effects	Time fixed effects
GDP	-2.18	1.08	-1.94	-2.11
OIL	-1.85	2.87	-2.17	-1.85
ΔGDP	-8.05	-7.89	-6.27	-8.92
ΔOIL	-6.76	-7.14	-6.77	-6.30

Δ denotes first differences. All variables are in natural logarithms.

Data Source: World Bank (2013)

The results show that all variables across countries has a unit root therefore we must use first difference to stationarity in variables. Having established that the variables are I(1), we proceed to

test whether a long-run relationship might exist between them. We first implement the following equation:

$$GDP_{it} = \alpha_i + \delta_i t + \beta_i OIL_{it} + \varepsilon_{it} \qquad (4)$$

Where it allows for cointegrating vectors of differing magnitudes between countries, as well as country (α) and time (δ) fixed effects. Table 2 reports the panel cointegration estimation results. For the all statistics significantly we can reject the null of no cointegration. Thus, it can be seen that the GDP and OIL move together in the long run. That is, there is a long-run steady state relationship between oil consumption and GDP for a cross-section of countries.

Table-2. Panel cointegration tests

	No time effects	Time fixed effects
Panel variance	1.12	1.38
Panel ρ	-1.02	0.73
Panel PP	-1.38	-1.01
Panel ADF	-2.04	-2.89
Group ρ	-0.63	1.47
Group PP	-1.12	-1.19
Group ADF	-2.69	-2.79

We use the Eviews (IHS Inc, Econometrics Software, USA) to estimate this value.

The next step is to test whether the variables are cointegrated using (Pedroni, 1999) (Pedroni, 2001; 2004).

Table 3 reports the results of the individual and panel FMOLS. The coefficient of Oil (oil consumption) is statistically significant at the 5% level that is positive as expected by the theory. The elasticity of oil consumption with respect to GDP are significantly smaller than 1.

The FMOLS estimates of the elasticity of oil consumption with respect to GDP range from 0.25 (Ecuador) to 0.56 (Qatar) this coefficients are statistically significant at the 5% level for many of this countries. The coefficient of export is positive and statistically significant in all countries; that shows in the short run and the long run, an increase in export tends to promote GDP.

Table-3. Full modified OLS estimates (dependent variable is GDP)

Country groupings	Oil consumption (OIL)
Iran	0.45 (2.87)
Iraq	0.29 (3.16)
Saudi Arabia	0.42 (4.37)
UAE	0.54 (3.48)
Oman	0.29 (2.98)
Qatar	0.56 (3.65)
Kuwait	0.31 (5.28)
Angola	0.28 (3.85)

Algeria	0.36 (6.16)
Venezuela	0.44 (4.29)
Nigeria	0.40 (3.87)
Ecuador	0.25 (2.49)
Panel (without time dummies)	0.38 (6.65)
Panel (with time dummies)	0.43 (5.08)

Data Source: World Bank (2013), t-statistics are in parentheses. We use the Eviews (IHS Inc, Econometrics Software, USA) to estimate this value.

4.2. Panel Causality Tests

The following panel VAR model is considered to test for causality between oil consumption and GDP:

$$LGDP_{it} = \alpha_{1j} + \sum_{i=1}^{k} \beta_{11ik} LGDP_{it-k} + \sum_{i=1}^{k} \beta_{12ik} LOIL_{it-k} + \delta_{1i} ECT_{it-1} + u_{1it}$$

$$LOIL_{it} = \alpha_{2j} + \sum_{i=1}^{k} \beta_{21ik} LGDP_{it-k} + \sum_{i=1}^{k} \beta_{22ik} LOIL_{it-k} + \delta_{2i} ECT_{it-1} + u_{2it}$$

Applying OLS to above equations provides biased estimates due to the correlation between the lagged dependent variables. The second step is to estimate the Granger causality model with a dynamic error correction:

$$\Delta GDP_{it} = \alpha_{1j} + \sum_{i=1}^{k} \beta_{11ik} \Delta GDP_{it-k} + \sum_{i=1}^{k} \beta_{12ik} \Delta OIL_{it-k} + \delta_{1i} ECT_{it-1} + u_{1it} \quad (5)$$
$$\Delta OIL_{it} = \alpha_{2j} + \sum_{i=1}^{k} \beta_{21ik} \Delta GDP_{it-k} + \sum_{i=1}^{k} \beta_{22ik} \Delta OIL_{it-k} + \delta_{2i} ECT_{it-1} + u_{2it} \quad (6)$$

where Δ denotes first differencing and k is the lag length and is chosen optimally for each country using a step-down procedure up to a maximum of two lags.

For short-run causality, we can test $H_0: \beta_{12ik} = 0$ for all i and k in Eq. (5) or $H_0: \beta_{21ik} = 0$ for all i and k in Eq. (6). The long-run causality can be tested by looking at the significance of the speed of adjustment δ, which is the coefficient of the error correction term, ECT_{it-1}. The significance of k indicates the long-run relationship of the cointegrated process, and so movements along this path can be considered permanent.

Finally, panel causality test between GDP and oil consumption results are shown in Table 4. The optimal lag structure chosen using the SIC (Schwartz criterion information) is a two-year lag. We find that the oil consumption equations are significant at the 5% level, implying a short- run and causalities. In addition, there are short-run causal relationships running from oil consumption to economic growth and vice versa. Moreover, the error correction term is statistically significant at the 5% level also denoting a relative slow speed of adjustment to long-run equilibrium. In terms of Eq. (5), it appears that oil consumption has a statistically significant impact on GDP in short – run

and oil consumption does not have impact on economic growth in long – run. Based on results obtained from Eq. (6), it is surprising that GDP has a positive and statistically significant impact on oil consumption in the long run. But oil consumption has not a statistically significant impact on GDP and the long run.

The bidirectional causality shows that oil conservation may improve economic growth in developing countries regardless of being transitory or permanent that supports the feedback hypothesis for these countries. The relationship also cannot refute the neutrality hypothesis advanced in respect of these countries for the energy- income relationship in long run.

Table-4. Panel causality tests

Dependent variable	Source of causation (independent variable)				
	Short run		Long run		
	ΔGDP	ΔOIL	ε	$\varepsilon/\Delta GDP$	ε/ΔOIL
ΔGDP	-	2.88 (0.01)	0.35 (0.04)	-	0.88 (0.19)
ΔOIL	1,98 (0.02)	-	0.41 (0.03)	2.06 (0.02)	-

P-value in parenthesis.

Data Source: World Bank (2013), we use the Eviews (IHS Inc, Econometrics Software, USA) to estimate this value.

5. CONCLUSIONS

The study of the causal relationship between oil consumption and economic growth is of interest in terms of designing appropriate energy policies in different countries. This paper employs data on OPEC countries from 1980 to 2011 to examine the causal relationship between GDP and oil consumption. Our evidence shows results suggesting that there is a short run steady-state relationship between economic growth and oil consumption for a cross-section of countries. This paper applies the panel cointegration technique to investigate the relationship between oil consumption and GDP across these countries. The findings have practical policy implications for decision makers in the area of macroeconomic planning, as energy conservation is a feasible policy with no damaging repercussions on economic growth for this group of countries. It is very important for low income countries to adopt appropriate energy policy in order to promote economic growth. Since these countries have a high oil exports, efficient use of oil and substituting of gas, electricity and technology for oil could be good policy measures.

REFERENCE

Abbasinejad, H., F. Gudarzi, Yazdan. and G. Asghari, E., 2012. The relationship between energy consumption, energy prices and economic growth: Case study (opec countries). OPEC Energy Review, 36(3): 272-286.

Abdullah, H., N.A. Abu Bakar and S. Hassan, 2007. Analysis of FDI inflows to china from selected Asian countries: A panel cointegration approach, don't published.

Abosedra, S. and H. Baghestani, 1989. New evidence on the causal relationship between US energy consumption and gross national product. Journal of Energy Development, 14(1): 285-292.

Asafu-Adjaye, J., 2000. The relationship between energy consumption, energy prices and economic growth: Time series evidence from asian developing countries. Energy Economics, 22(6): 615–625.

Erol, U. and E.S.H. Yu, 1987. On the causal relationship between energy and income for industrialized countries. Journal of Energy and Development, 13(1): 113–122.

Ghosh, S., 2002. Electricity consumption and economic growth in india,. Energy Policy, 30(2): 125–129.

Glasure, Y.U. and A.R. Lee, 1997. Cointegration, error-correction, and the relationship between GDP and energy: the case of South Korea and Singapore. Resource and Energy Economics, 20(1): 17-25.

Gudarzi farahani, Y. and H. Sadr Seyed Mohammad, 2012. Causality between oil consumption and economic growth in iran: An ardl testing approach. Asian Economic and Financial Review, 2(6): 606-614.

Hondroyiannis, G., S. Lolos and E. Papapetrou, 2002. Energy consumption and economic growth: Assessing the evidence from greece. Energy Economics, 24(4): 319-336.

Ighodaro, C.A.U., 2010. Cointegration and causality relationship between energy consumption and economic growth: Future empirical evidence for nigeria. Journal of Business Economics and Management, 11(1): 97–111.

Levine, A. and C.F. Lin, 1993. Unit root tests in panel data: Asymptotic and finite sample properties, working paper. Department of economics. University of California at San Diego.

Masih, A.M.M. and R. Masih, 1998. A multivariate cointegrated modeling approach in testing temporal causality between energy consumption, real income and prices with an application to two asian ldcs. Applied Economics, 30(10): 1287–1298.

Odhiambo, M.N., 2010. Oil prices and economic growth in South Africa: An ARDL Testing Approach.

Pedroni, P., 1999. Critical values for cointegration tests in heterogeneous panels with multiple regressors. Oxford Bulletin of Economics and Statistics, 61: 653– 670.

Pedroni, P., 2001; 2004. Purchasing power parity tests in cointegrated panels. The Review Economic Statistics, 83(4): 727-731.

Pedroni, P., 2004. Panel cointegration: Asymptotic and finite samples properties of pooled time series tests with an application to the PPP hypothesis. Economic Theory, 20(1): 597-625.

Sims, C.A., 1972. Money, income and causality. American Economic Review, 62(2): 540-552.

Soytas, U. and R. Sari, 2003. Energy consumption and gdp: Causality relationship in g-7 countries and emerging markets. Energy Economics, 25(1): 33–37.

World Bank, 2013. Development Challenges in the New Century Washington DC, the World Bank.